

**REMARKS**

Reconsideration is respectfully requested.

Claims 1-19 are presently pending in the application. Claims 6 and 15 have been cancelled and Claims 1, 4-5, 10, and 13-14 have been amended.

Claims 5 and 14 stand rejected under 35 U.S.C. §112, ¶1, as containing subject matter not described in the Specification. The Office Action states that the Specification page 10, lines 2-4 does not provide support for the further step of plasma treatment after the plasma treatment process performed during the deposition.

Applicants respectfully disagree. It is inaccurate to so narrowly interpret the meaning of the text "a plasma treatment ... can be performed during or after the deposition ..." (Specification page 10, lines 2-4) as conveying a meaning that a second post deposition plasma treatment following a first plasma treatment performed during the deposition is prohibited. This interpretation assumes that no plasma treatment can be performed after the initial one of the deposition process; however, such a meaning is neither suggested nor implied in the Specification or the drawings. The meaning of the text should rather be plainly understood as that the plasma treatment can be performed during the deposition or after the deposition regardless of whether or not a plasma treatment has already been performed during the deposition. Thus, a number of heat treatments can be performed during the process whether or not a deposition has been performed, and in no way this is inconsistent with the disclosure of the present application.

Nevertheless, Claims 5 and 14 have been amended to recite that "a plasma treatment is continued after the formation of the glue layer", and this language does not require

separate post deposition heat treatment process. By this amendment, the issues relating to the rejections of Claims 5 and 14 are now moot. An indication thereof is respectfully requested.

Claims 1-18 stand rejected under 35 U.S.C. §103(a) as being unpatentable over the admitted prior art (APA) taken with U.S. Patent No. 6,022,800 (Ho), U.S. Patent No. 6,436,819 (Zhang), U.S. Patent No. 6,187,631 (Zhao), and U.S. Patent No. 6,319,766 (Bakli). (The "et al." suffix after a reference name is omitted.)

As to Claims 1 and 10, Office Action indicates Bakli, col. 6, lines 7-9, as disclosing the heat treatment performed during the deposition process or as a post deposition process. However, Bakli does not disclose a specific example of performing a plasma treatment during the CVD of a titanium material such as titanium or titanium nitride. Bakli uses a more generalized term "metal nitrides" in its disclosure, but its invention is directed to the use of tantalum and tantalum nitride, not a titanium material. The Bakli col. 6, lines 7-9 describes a general feature of a machine having a CVD chamber that it can perform heat plasma treatment during a CVD process. But, nowhere does Bakli affirmatively teach or suggest the concurrent steps of plasma treatment and CVD of a titanium material. It is respectfully suggested that the Bakli teaching of "metal nitrides" is a generalized teaching, and is more in the way of an invitation to experiment rather than a clear teaching of the claimed limitation.

Zhao and Harshfield of the cited references teach just the opposite that a plasma treatment should be performed **after** the deposition of titanium. No other cited references disclose this claimed feature of performing a plasma treatment during the deposition of titanium. Applicants have already pointed out in the last response that Zhao describes the heat treatment of a titanium nitride not as a concurrent step but as a second step after the deposition of a TiN layer. In addition, Harshfield (cited against Claims 5 and 14 in the previous Action and against Claim 19 in the present Action) also describes the plasma

treatment as an "optional post-deposition treatment" (See Harshfield col. 4, lines 65-67), not as a step that can be performed concurrently with the step of titanium deposition. The mere use of the term "metal nitride" in Bakli (in view of the teachings in Zhao and Harshfield) that are inconsistent with Bakli and without a specific showing in Bakli about the use of titanium material as applied in the process of its col. 6, lines 7-9) is inadequate for an interpretation of the text in Bakli col. 6, lines 7-9, as though it also covers a titanium material as well as a tantalum material.

When more than one cited prior art references (Zhao and Harshfield) specifically teach against the concurrent performance steps of plasma treatment and CVD of titanium material, the teachings in Bakli, col. 6, lines 7-9, that relate to a general feature of a machine having a CVD chamber without a specific and affirmative showing that the same feature of the machine is also applicable to titanium, not just tantalum material, provides an improper ground to combine Bakli with the other references. When two references specifically teach against the treatment of plasma concurrently during the deposition process of titanium, the combination of these references is improper and cannot support the limitations claimed in Claims 1 and 10. This impermissible combination of references is respectfully believed to be a result of impermissible hindsight, as emanating only from the understanding derived from the disclosure of the present application. MPEP §2143.

For this reason alone, Applicants respectfully submit that Claim 1, in its unamended form, has been distinguished from the cited prior art references and is considered allowable. Nevertheless, Claims 1 and 10 have been amended to further distinguish the claimed invention from the prior art. The limitations "the glue layer being made up of both Ti and TiN layers by using a TDMET source" are added in Claims 1 and 10, and this limitations are not taught or suggested in any of the cited prior art references.

For the reasons set forth above, Applicants respectfully submit that the claims 5, 7-14, and 16-19, now pending in this application, are in condition for allowance over the prior art of record. This amendment is considered to be responsive to all points raised in the Office Action. Accordingly, prompt allowance and passage of the application to issue are earnestly solicited. Should the Examiner have any remaining questions or concerns, the Examiner is encouraged to contact the undersigned attorney by telephone to expeditiously resolve such concerns.

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Respectfully submitted,

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PATENT

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application: In Cheol RYU

Serial No.: 10/034,497

Filed: December 29, 2001

For: METHOD OF FORMING A CONTACT  
FOR A SEMICONDUCTOR DEVICE]  
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GRP ART UNIT: 2814

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**CLAIM-MARKED UP VERSION**

MAR 11 2004

Please cancel Claims 6 and 15 without prejudice.

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Please amend Claims 1, 4-5, 10, and 13-14 as set forth below:

1. (Twice Amended) A method of forming a contact for a semiconductor device, comprising the steps of:

forming a first interlayer dielectric layer on a silicon substrate;

forming a conductive material pattern on a portion of the first interlayer dielectric layer;

forming a second interlayer dielectric layer over the first interlayer dielectric layer and over the conductive material pattern;

forming first and second contact holes by selectively removing the second and the first interlayer dielectric layers so as to respectively expose a portion of the conductive material pattern and a portion of the silicon substrate;

forming a glue layer on the first and the second interlayer dielectric layer including over the first and the second contact holes, the glue layer [**including a CVD] being made up of both Ti and TiN layers by using a TDMET source;**

treating plasma on the glue layer using N<sub>2</sub> or H<sub>2</sub>, alone or in combination during the step of forming the glue layer; and

filling the first and the second contact holes with a tungsten layer by forming the tungsten layer on the glue layer.

4. (Once Amended) The method of claim 1, wherein the [CVD TiN] glue layer is deposited to a thickness of less than about 400Å by using a TDMAT [, TDMET] or TUN source instead of the TDMET source.

5. (Twice Amended) The method of claim 4, wherein a plasma treatment is [further performed] continued after the [deposition of the CVD TiN layer while using N<sub>2</sub> and I<sub>2</sub> gas either together or alone] formation of the glue layer.

6. Please cancel Claim 6 without prejudice.

10. (Twice Amended) A method of forming a contact for a semiconductor device, comprising the steps of:

forming a first interlayer dielectric layer on a silicon substrate;

forming a conductive material pattern on a portion of the first interlayer dielectric layer, wherein the conductive material pattern has a lower etch rate than the first interlayer dielectric layer;

forming a second interlayer dielectric layer over the first interlayer dielectric layer and over the conductive material pattern;

selectively and sequentially removing the second and the first interlayer dielectric layers so as to form first and second contact holes, wherein the second contact hole has a depth greater than the first contact hole, wherein the first contact hole exposes a portion of the conductive material pattern, and wherein the second contact hole exposes a portion of the silicon substrate;

forming [at least one CVD TiN] a glue layer made up of both Ti and TiN layers by using a TDMET source on the first and the second interlayer dielectric layers including over the first and the second contact holes;

treating plasma on the glue layer using  $N_2$  or  $H_2$ , alone or in combination,  
during the step of forming the glue layer; and  
forming a tungsten layer on the CVD TiN layer so as to fill the first and the  
second contact holes.

13. **(Once Amended)** The method of claim 10, wherein the CVD TiN layer is deposited with a thickness of less than about 400Å by using a TDMAT [, TDMET] or  $TiCl_4$  source instead of the TDMET source.

14. **(Twice Amended)** The method of claim 13, wherein a plasma treatment is [further performed] continued after the [deposition of the CVD TiN layer while using  $N_2$  and  $H_2$  gas either together or alone] formation of the glue layer.

15. Please cancel Claim 15 without prejudice.

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